

Listing of Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) An atomic layer deposition (ALD) process for depositing a metal nitride layer comprised of a plurality of metal nitride monolayers on a substrate, comprising:

(a) providing a substrate with a patterned layer formed thereon, the patterned layer comprising an opening;

(b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels;

(c) flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate;

(d) purging said ALD process chamber with an inert gas to leave a monolayer of nitrogen containing reactant on said substrate;

(e) flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer wherein the metal precursor comprises at least one of $\text{Ti(OCH(CH}_3)_2\}$, TDMAT, or and TDEAT;

(f) purging said ALD process chamber to remove unreacted metal precursor; and

(g) repeating the sequence of steps (c), (d), (e), (f) until an acceptable thickness of the metal nitride layer is reached fills the opening to form a metal nitride plug.

2. (Original) The method of claim 1 wherein the temperature of said ALD process chamber is between about 250°C and 750°C and the pressure in said ALD process chamber is maintained in a range from about 0.1 to 50 Torr.

3. (Canceled).

4. (Canceled).

5. (Previously Presented) The method of claim 1 wherein said metal precursor is flowed into said ALD process chamber at a rate of about 500 to 10000 standard cubic centimeters per minute (sccm) for a period of about 0.1 to 3 seconds.

6. (Original) The method of claim 1 wherein said metal precursor gas is transported into said ALD process chamber by an inert gas having a flow rate of about 500 to 10000 sccm.

7. (Original) The method of claim 1 wherein the inert gas purging of said ALD process chamber is comprised of flowing argon, helium, or N₂ with a flow rate from about 500 to 10000 sccm for a period of about 0.1 to 10 seconds.

8. (Original) The method of claim 1 wherein the nitrogen containing reactant is comprised of NH₃, N₂H₄, or N₂ and is flowed at a rate of about 500 to 10000 sccm for a period of about 0.1 to 3 seconds.

9. (Original) The method of claim 8 further comprised of a generating a plasma to assist in the reaction between the nitrogen containing reactant and the metal precursor.

10. (Original) The method of claim 1 wherein the film thickness of the metal nitride layer is between 0 and about 50 nm.

11. (Currently Amended) An atomic layer deposition (ALD) process for depositing a metal nitride layer comprised of a plurality of metal nitride monolayers on a substrate, comprising:

- (a) providing a substrate with a patterned layer formed thereon, the patterned layer comprises an opening;
- (b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels;
- (c) flowing a metal precursor into said ALD process chamber so that said metal precursor is deposited on said substrate, wherein said metal precursor comprises at least one of Ti{OCH(CH₃)₂}₄, TDMAT, or and TDEAT;
- (d) purging said ALD process chamber with an inert gas to leave a monolayer of metal precursor on said substrate;
- (e) flowing a nitrogen containing reactant into said ALD process chamber, said nitrogen containing reactant reacts with said metal precursor monolayer to form a metal nitride monolayer;
- (f) purging said ALD process chamber to remove unreacted nitrogen containing reactant; and
- (g) repeating the sequence of steps (c), (d), (e), (f) until an acceptable thickness of the metal nitride layer is reached fills the opening to form a metal nitride plug.

12. (Currently Amended) A method of forming a metal nitride layer on a substrate, said substrate comprised of an upper dielectric layer having at least one opening, comprising:

- (a) providing a substrate having an upper dielectric layer that has a pattern formed therein comprised of at least one opening;
- (b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels;
- (c) flowing a metal precursor into said ALD process chamber so that said metal precursor is deposited on said substrate, wherein said metal precursor comprises at least one of Ti{OCH(CH₃)₂}₄, TDMAT, or and TDEAT;
- (d) purging said chamber with an inert gas to leave a monolayer of metal precursor on said substrate;
- (e) flowing a nitrogen containing reactant into said ALD process chamber, said nitrogen containing reactant reacts with said metal precursor monolayer to give a metal nitride monolayer on said substrate;
- (f) purging said ALD process chamber to remove unreacted nitrogen containing reactant;
- (g) repeating the sequence of steps (c), (d), (e), (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening to form a metal nitride plug; and
- (h) planarizing said composite layer to be coplanar with said dielectric layer.

13. (Original) The method of claim 12 wherein said dielectric layer is phosphosilicate glass (PSG), borophosphosilicate glass (BPSG), or a low k dielectric material with a thickness between about 1000 and 10000 Angstroms.

14. (Original) The method of claim 12 wherein said opening is a contact hole, via, or trench and has a width that is about 100 nm or less.

15. (Original) The method of claim 12 wherein the temperature of said ALD process chamber is between about 250°C and 750°C and the pressure in said ALD process chamber is maintained in a range from about 0.1 to 50 Torr.

16-17. (Cancelled).

18. (Original) The method of claim 12 wherein said metal precursor is flowed at a rate of about 500 to 10000 sccm for a period of about 0.1 to 3 seconds.

19. (Original) The method of claim 12 wherein said metal precursor is transported into the ALD process chamber by an inert gas having a flow rate of about 500 to 10000 sccm

20. (Original) The method of claim 12 wherein the inert gas purging of said ALD process chamber is comprised of flowing argon, helium, or N₂ with a flow rate from about 500 to 10000 sccm for a period of about 0.1 to 10 seconds.

21. (Original) The method of claim 12 wherein the nitrogen containing reactant is comprised of NH₃, N₂H₄, or N₂ and is flowed at a rate of about 500 to 10000 sccm for a period of about 0.1 to 3 seconds.

22. (Original) The method of claim 21 further comprised of a generating a plasma to assist in the reaction between the nitrogen containing reactant and the metal precursor.

23. (Original) The method of claim 12 further comprised of performing a film thickness measurement after several repetitions of the sequence of steps (c), (d), (e), (f) to determine if an acceptable thickness of said composite layer has been achieved.

24. (Original) The method of claim 12 wherein said planarization is performed with a chemical mechanical polish (CMP) step.

25-51. (Canceled).

52. (Currently Amended) A method for forming an interconnect:
providing a substrate;
forming a conductive layer within the substrate;
depositing a dielectric layer on the substrate;
forming an opening within the dielectric layer;
depositing a titanium-containing composite layer on the substrate to fill the opening; and
planarizing the titanium-containing composite layer to be coplanar with the dielectric layer, wherein depositing the titanium-containing composite layer comprises flowing a metal precursor that comprises at least one of $Ti\{OCH(CH_3)_2\}_4$, TDMAT or and TDEAT into a chamber, wherein depositing a composite layer on the substrate further comprises:
purging an inert gas into the chamber to remove metal precursor not bonded to the substrate;
flowing a nitrogen-containing reactant into the chamber to form one of the plurality of metal nitride monolayer; and
purging an inert gas into the chamber to remove nitrogen-containing reactant not reacted with the metal precursor, and
wherein the purging step for purging an inert gas to remove metal precursor not bonded to the substrate, the flowing step for flowing a nitrogen-containing reactant into the chamber to form one of the plurality of metal nitride monolayer, and the purging step for purging an inert gas into the chamber to remove nitrogen-containing reactant not reached with the metal precursor are performed repeatedly until the composite layer fills the opening to form a titanium-containing composite plug.

53. (Previously Presented) The method of claim 52, wherein the composite layer comprises a plurality of metal nitride monolayers.

54. (Previously Presented) The method of claim 53, wherein each of the plurality of metal nitride monolayers comprises at least one metal and nitrogen.

55-56. (Canceled).